

## CLAIMS

What is claimed is:

1. A copolymer comprising an isoolefin and an alkylstyrene, the copolymer having a copolymer sequence distribution defined by:

$$F = 1 - \{m A / (1 + mA)\}$$

wherein  $m$  is the copolymer sequence distribution parameter;  $A$  is the molar ratio of alkylstyrene to isoolefin in the copolymer; and  $F$  is the alkylstyrene-isoolefin-alkylstyrene triad fraction in the copolymer; wherein  $m$  is from less than 38.

2. The copolymer of claim 1, wherein  $m$  is from less than 35.
3. The copolymer of claim 1, wherein  $m$  is from less than 30.
4. The copolymer of claim 1, wherein  $m$  is from 1-38.
5. The copolymer of claim 1, wherein  $m$  is from 1-35.
6. The copolymer of claim 1, wherein  $m$  is from 1-30.
7. The copolymer of any of the preceding claims, wherein the isoolefin is isobutylene and the alkylstyrene is methylstyrene, preferably, *para*-methylstyrene.
8. The copolymer of any of the preceding claims, wherein the alkylstyrene content is from greater than 0.5 mol%.

9. The copolymer of any of the preceding claims, wherein the alkylstyrene content is from greater than 1.5 mol%.
10. The copolymer of any of the preceding claims, wherein the alkylstyrene content is from greater than 6.0 mol%.
11. The copolymer of any of the preceding claims, wherein the alkylstyrene content is from greater than 12.5 mol%.
12. A copolymer produced by the process comprising contacting an isoolefin, preferably isobutylene, an alkylstyrene, one or more Lewis acid(s), one or more initiator(s), and a diluent comprising one or more hydrofluorocarbon(s) (HFC's); the copolymer having a copolymer sequence distribution defined by:

$$F = 1 - \{m A / (1 + mA)\}$$

wherein **m** is the copolymer sequence distribution parameter; **A** is the molar ratio of alkylstyrene to isoolefin in the copolymer; and **F** is the alkylstyrene-isoolefin-alkylstyrene triad fraction in the copolymer; wherein **m** is from less than 38.

13. The copolymer of claim 12, wherein **m** is from less than 35.
14. The copolymer of claim 12, wherein **m** is from less than 30.
15. The copolymer of claim 12, wherein **m** is from 1-38.
16. The copolymer of claim 12, wherein **m** is from 1-35.
17. The copolymer of claim 12, wherein **m** is from 1-30.

18. The copolymer of any of claims 12-17, wherein the alkylstyrene is methylstyrene, preferably *para*-methylstyrene.
19. The copolymer of any of claims 12-18, wherein the alkylstyrene content is from greater than 0.5 mol%.
20. The copolymer of any of claims 12-18, wherein the alkylstyrene content is from greater than 1.5 mol%.
21. The copolymer of any of claims 12-18, wherein the alkylstyrene content is from greater than 6.0 mol%.
22. The copolymer of any of claims 12-18, wherein the alkylstyrene content is from greater than 12.5 mol%.
23. The copolymer of any of claims 12-22, wherein one or more hydrofluorocarbon(s) is represented by the formula:  $C_xH_yF_z$  wherein x is an integer from 1 to 40 and y and z are integers of one or more.
24. The copolymer of claim 23, wherein x is from 1 to 10.
25. The copolymer of claim 23, wherein x is from 1 to 6.
26. The copolymer of claim 23, wherein x is from 1 to 3.
27. The copolymer of claim 23, wherein the one or more hydrofluorocarbon(s) is independently selected from the group consisting of fluoromethane; difluoromethane; trifluoromethane; fluoroethane; 1,1-difluoroethane; 1,2-difluoroethane; 1,1,1-trifluoroethane; 1,1,2-trifluoroethane; 1,1,1,2-tetrafluoroethane; 1,1,2,2-tetrafluoroethane; 1,1,1,2,2-pentafluoroethane; 1-fluoropropane; 2-fluoropropane; 1,1-difluoropropane; 1,2-difluoropropane; 1,3-difluoropropane; 2,2-difluoropropane; 1,1,1-

trifluoropropane; 1,1,2-trifluoropropane; 1,1,3-trifluoropropane; 1,2,2-trifluoropropane; 1,2,3-trifluoropropane; 1,1,1,2-tetrafluoropropane; 1,1,1,3-tetrafluoropropane; 1,1,2,2-tetrafluoropropane; 1,1,2,3-tetrafluoropropane; 1,1,3,3-tetrafluoropropane; 1,2,2,3-tetrafluoropropane; 1,1,1,2,2-pentafluoropropane; 1,1,1,2,3-pentafluoropropane; 1,1,1,3,3-pentafluoropropane; 1,1,2,2,3-pentafluoropropane; 1,1,2,3,3-pentafluoropropane; 1,1,1,2,2,3-hexafluoropropane; 1,1,1,2,3,3-hexafluoropropane; 1,1,1,3,3,3-hexafluoropropane; 1,1,1,2,2,3,3-heptafluoropropane; 1,1,1,2,3,3,3-heptafluoropropane; 1-fluorobutane; 2-fluorobutane; 1,1-difluorobutane; 1,2-difluorobutane; 1,3-difluorobutane; 1,4-difluorobutane; 2,2-difluorobutane; 2,3-difluorobutane; 1,1,1-trifluorobutane; 1,1,2-trifluorobutane; 1,1,3-trifluorobutane; 1,1,4-trifluorobutane; 1,2,2-trifluorobutane; 1,2,3-trifluorobutane; 1,3,3-trifluorobutane; 2,2,3-trifluorobutane; 1,1,1,2-tetrafluorobutane; 1,1,1,3-tetrafluorobutane; 1,1,1,4-tetrafluorobutane; 1,1,2,2-tetrafluorobutane; 1,1,2,3-tetrafluorobutane; 1,1,2,4-tetrafluorobutane; 1,1,3,3-tetrafluorobutane; 1,1,3,4-tetrafluorobutane; 1,1,4,4-tetrafluorobutane; 1,2,2,3-tetrafluorobutane; 1,2,2,4-tetrafluorobutane; 1,2,3,3-tetrafluorobutane; 1,2,3,4-tetrafluorobutane; 2,2,3,3-tetrafluorobutane; 1,1,1,2,2-pentafluorobutane; 1,1,1,2,3-pentafluorobutane; 1,1,1,2,4-pentafluorobutane; 1,1,1,3,3-pentafluorobutane; 1,1,1,3,4-pentafluorobutane; 1,1,1,4,4-pentafluorobutane; 1,1,2,2,3-pentafluorobutane; 1,1,2,2,4-pentafluorobutane; 1,1,2,3,3-pentafluorobutane; 1,1,2,4,4-pentafluorobutane; 1,1,3,3,4-pentafluorobutane; 1,2,2,3,3-pentafluorobutane; 1,2,2,3,4-pentafluorobutane; 1,1,1,2,2,3-hexafluorobutane; 1,1,1,2,2,4-hexafluorobutane; 1,1,1,2,3,3-hexafluorobutane; 1,1,1,2,3,4-hexafluorobutane; 1,1,1,2,4,4-hexafluorobutane; 1,1,1,3,3,4-hexafluorobutane; 1,1,1,3,4,4-hexafluorobutane; 1,1,1,4,4,4-hexafluorobutane; 1,1,2,2,3,3-hexafluorobutane; 1,1,2,2,3,4-hexafluorobutane; 1,1,2,2,4,4-hexafluorobutane; 1,1,2,3,3,4-hexafluorobutane; 1,1,2,3,4,4-hexafluorobutane; 1,2,2,3,3,4-hexafluorobutane;

hexafluorobutane; 1,1,1,2,2,3,3-heptafluorobutane; 1,1,1,2,2,4,4-  
 heptafluorobutane; 1,1,1,2,2,3,4-heptafluorobutane; 1,1,1,2,3,3,4-  
 heptafluorobutane; 1,1,1,2,3,4,4-heptafluorobutane; 1,1,1,2,4,4,4-  
 heptafluorobutane; 1,1,1,3,3,4,4-heptafluorobutane; 1,1,1,2,2,3,3,4-  
 octafluorobutane; 1,1,1,2,2,3,4,4-octafluorobutane; 1,1,1,2,3,3,4,4-  
 octafluorobutane; 1,1,1,2,2,4,4,4-octafluorobutane; 1,1,1,2,3,4,4,4-  
 octafluorobutane; 1,1,1,2,2,3,3,4,4-nonafluorobutane; 1,1,1,2,2,3,4,4,4-  
 nonafluorobutane; 1-fluoro-2-methylpropane; 1,1-difluoro-2-  
 methylpropane; 1,3-difluoro-2-methylpropane; 1,1,1-trifluoro-2-  
 methylpropane; 1,1,3-trifluoro-2-methylpropane; 1,3-difluoro-2-  
 (fluoromethyl)propane; 1,1,1,3-tetrafluoro-2-methylpropane; 1,1,3,3-  
 tetrafluoro-2-methylpropane; 1,1,3-trifluoro-2-(fluoromethyl)propane;  
 1,1,1,3,3-pentafluoro-2-methylpropane; 1,1,3,3-tetrafluoro-2-  
 (fluoromethyl)propane; 1,1,1,3-tetrafluoro-2-(fluoromethyl)propane;  
 fluorocyclobutane; 1,1-difluorocyclobutane; 1,2-difluorocyclobutane; 1,3-  
 difluorocyclobutane; 1,1,2-trifluorocyclobutane; 1,1,3-  
 trifluorocyclobutane; 1,2,3-trifluorocyclobutane; 1,1,2,2-  
 tetrafluorocyclobutane; 1,1,3,3-tetrafluorocyclobutane; 1,1,2,2,3-  
 pentafluorocyclobutane; 1,1,2,3,3-pentafluorocyclobutane; 1,1,2,2,3,3-  
 hexafluorocyclobutane; 1,1,2,2,3,4-hexafluorocyclobutane; 1,1,2,3,3,4-  
 hexafluorocyclobutane; 1,1,2,2,3,3,4-heptafluorocyclobutane; vinyl  
 fluoride; 1,1-difluoroethene; 1,2-difluoroethene; 1,1,2-trifluoroethene; 1-  
 fluoropropene, 1,1-difluoropropene; 1,2-difluoropropene; 1,3-  
 difluoropropene; 2,3-difluoropropene; 3,3-difluoropropene; 1,1,2-  
 trifluoropropene; 1,1,3-trifluoropropene; 1,2,3-trifluoropropene; 1,3,3-  
 trifluoropropene; 2,3,3-trifluoropropene; 3,3,3-trifluoropropene; 1-fluoro-  
 1-butene; 2-fluoro-1-butene; 3-fluoro-1-butene; 4-fluoro-1-butene; 1,1-  
 difluoro-1-butene; 1,2-difluoro-1-butene; 1,3-difluoropropene; 1,4-  
 difluoro-1-butene; 2,3-difluoro-1-butene; 2,4-difluoro-1-butene; 3,3-  
 difluoro-1-butene; 3,4-difluoro-1-butene; 4,4-difluoro-1-butene; 1,1,2-  
 trifluoro-1-butene; 1,1,3-trifluoro-1-butene; 1,1,4-trifluoro-1-butene; 1,2,3-  
 trifluoro-1-butene; 1,2,4-trifluoro-1-butene; 1,3,3-trifluoro-1-butene; 1,3,4-

trifluoro-1-butene; 1,4,4-trifluoro-1-butene; 2,3,3-trifluoro-1-butene; 2,3,4-trifluoro-1-butene; 2,4,4-trifluoro-1-butene; 3,3,4-trifluoro-1-butene; 3,4,4-trifluoro-1-butene; 4,4,4-trifluoro-1-butene; 1,1,2,3-tetrafluoro-1-butene; 1,1,2,4-tetrafluoro-1-butene; 1,1,3,3-tetrafluoro-1-butene; 1,1,3,4-tetrafluoro-1-butene; 1,1,4,4-tetrafluoro-1-butene; 1,2,3,3-tetrafluoro-1-butene; 1,2,3,4-tetrafluoro-1-butene; 1,2,4,4-tetrafluoro-1-butene; 1,3,3,4-tetrafluoro-1-butene; 1,3,4,4-tetrafluoro-1-butene; 1,4,4,4-tetrafluoro-1-butene; 2,3,3,4-tetrafluoro-1-butene; 2,3,4,4-tetrafluoro-1-butene; 2,4,4,4-tetrafluoro-1-butene; 3,3,4,4-tetrafluoro-1-butene; 3,4,4,4-tetrafluoro-1-butene; 1,1,2,3,3-pentafluoro-1-butene; 1,1,2,3,4-pentafluoro-1-butene; 1,1,2,4,4-pentafluoro-1-butene; 1,1,3,3,4-pentafluoro-1-butene; 1,1,3,4,4-pentafluoro-1-butene; 1,1,4,4,4-pentafluoro-1-butene; 1,2,3,3,4-pentafluoro-1-butene; 1,2,3,4,4-pentafluoro-1-butene; 1,2,4,4,4-pentafluoro-1-butene; 2,3,3,4,4-pentafluoro-1-butene; 2,3,4,4,4-pentafluoro-1-butene; 3,3,4,4,4-pentafluoro-1-butene; 1,1,2,3,3,4-hexafluoro-1-butene; 1,1,2,3,4,4-hexafluoro-1-butene; 1,1,2,4,4,4-hexafluoro-1-butene; 1,2,3,3,4,4-hexafluoro-1-butene; 1,2,3,4,4,4-hexafluoro-1-butene; 2,3,3,4,4,4-hexafluoro-1-butene; 1,1,2,3,3,4,4-heptafluoro-1-butene; 1,1,2,3,4,4,4-heptafluoro-1-butene; 1,1,3,3,4,4,4-heptafluoro-1-butene; 1,2,3,3,4,4,4-heptafluoro-1-butene; 1-fluoro-2-butene; 2-fluoro-2-butene; 1,1-difluoro-2-butene; 1,2-difluoro-2-butene; 1,3-difluoro-2-butene; 1,4-difluoro-2-butene; 2,3-difluoro-2-butene; 1,1,1-trifluoro-2-butene; 1,1,2-trifluoro-2-butene; 1,1,3-trifluoro-2-butene; 1,1,4-trifluoro-2-butene; 1,2,3-trifluoro-2-butene; 1,2,4-trifluoro-2-butene; 1,1,1,2-tetrafluoro-2-butene; 1,1,1,3-tetrafluoro-2-butene; 1,1,1,4-tetrafluoro-2-butene; 1,1,2,3-tetrafluoro-2-butene; 1,1,2,4-tetrafluoro-2-butene; 1,2,3,4-tetrafluoro-2-butene; 1,1,1,2,3-pentafluoro-2-butene; 1,1,1,2,4-pentafluoro-2-butene; 1,1,1,3,4-pentafluoro-2-butene; 1,1,1,4,4-pentafluoro-2-butene; 1,1,2,3,4-pentafluoro-2-butene; 1,1,2,4,4-pentafluoro-2-butene; 1,1,1,2,3,4-hexafluoro-2-butene; 1,1,1,2,4,4-hexafluoro-2-butene; 1,1,1,3,4,4-hexafluoro-2-butene; 1,1,1,4,4,4-hexafluoro-2-butene; 1,1,2,3,4,4-hexafluoro-2-butene; 1,1,1,2,3,4,4-

heptafluoro-2-butene; 1,1,1,2,4,4,4-heptafluoro-2-butene; and mixtures thereof.

28. The copolymer of claim 23, wherein the one or more hydrofluorocarbon(s) is independently selected from the group consisting of fluoromethane, difluoromethane, trifluoromethane, 1,1-difluoroethane, 1,1,1-trifluoroethane, 1,1,1,2-tetrafluoroethane, and mixtures thereof.
29. The copolymer of claim 23, wherein the diluent comprises from 15 to 100 volume % HFC based upon the total volume of the diluent.
30. The copolymer of claim 23, wherein the diluent comprises from 20 to 100 volume % HFC based upon the total volume of the diluent.
31. The copolymer of claim 23, wherein the diluent comprises from 25 to 100 volume % HFC based upon the total volume of the diluent.
32. The copolymer of claim 23, wherein the diluent further comprises a hydrocarbon, a non-reactive olefin, and/or an inert gas.
33. The copolymer of claim 32, wherein the hydrocarbon is a halogenated hydrocarbon other than an HFC.
34. The copolymer of claim 33, wherein the halogenated hydrocarbon is methyl chloride.
35. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $MX_4$ ;  
wherein M is a Group 4, 5, or 14 metal; and  
each X is a halogen.

36. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $MR_nX_{4-n}$ ;  
 wherein M is Group 4, 5, or 14 metal;  
 each R is a monovalent  $C_1$  to  $C_{12}$  hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;  
 $n$  is an integer from 0 to 4; and  
 each X is a halogen.
37. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $M(RO)_nR'_mX_{4-(m+n)}$ ;  
 wherein M is Group 4, 5, or 14 metal;  
 each RO is a monovalent  $C_1$  to  $C_{30}$  hydrocarboxy radical independently selected from the group consisting of an alkoxy, aryloxy, arylalkoxy, alkylaryloxy radicals;  
 each R' is a monovalent  $C_1$  to  $C_{12}$  hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;  
 $n$  is an integer from 0 to 4;  
 $m$  is an integer from 0 to 4, wherein the sum of  $n$  and  $m$  is not more than 4;  
 and  
 each X is a halogen.
38. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $M(RC=OO)_nR'_mX_{4-(m+n)}$ ;  
 wherein M is Group 4, 5, or 14 metal;  
 each  $RC=OO$  is a monovalent  $C_2$  to  $C_{30}$  hydrocarbacyl radical independently selected from the group consisting of an alkacyloxy, arylacyloxy, arylalkylacyloxy, alkylarylacyloxy radicals;  
 each R' is a monovalent  $C_1$  to  $C_{12}$  hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;



$n$  is an integer from 0 to 4;

$m$  is an integer from 0 to 4, wherein the sum of  $n$  and  $m$  is not more than 4;

and

each X is a halogen.

39. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $\text{MOX}_3$ ;  
wherein M is a Group 5 metal; and  
each X is a halogen.
40. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $\text{MX}_3$ ;  
wherein M is a Group 13 metal; and  
each X is a halogen.
41. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $\text{MR}_n\text{X}_{3-n}$ ;  
wherein M is a Group 13 metal;  
each R is a monovalent  $\text{C}_1$  to  $\text{C}_{12}$  hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;  
 $n$  is an integer from 1 to 3; and  
each X is a halogen.
42. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $\text{M}(\text{RO})_n\text{R}'_m\text{X}_{3-(m+n)}$ ;  
wherein M is a Group 13 metal;  
each RO is a monovalent  $\text{C}_1$  to  $\text{C}_{30}$  hydrocarboxy radical independently selected from the group consisting of an alkoxy, aryloxy, arylalkoxy, alkylaryloxy radicals;

each R' is a monovalent C<sub>1</sub> to C<sub>12</sub> hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;

*n* is an integer from 0 to 3;

*m* is an integer from 0 to 3, wherein the sum of *n* and *m* is from 1 to 3; and

each X is a halogen.

43. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $M(RC=OO)_nR'_mX_{3-(m+n)}$ ;

wherein M is a Group 13 metal;

each RC=OO is a monovalent hydrocarbacyl radical independently selected from the group independently selected from the C<sub>2</sub> to C<sub>30</sub> group consisting of an alkacyloxy, arylacyloxy, arylalkylacyloxy, alkylarylacyloxy radicals;

each R' is a monovalent C<sub>1</sub> to C<sub>12</sub> hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;

*n* is an integer from 0 to 3;

*m* is a integer from 0 to 3, wherein the sum of *n* and *m* is from 1 to 3; and

each X is a halogen.

44. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $MX_y$ ;

wherein M is a Group 15 metal;

each X is a halogen; and

*y* is 3, 4 or 5.

45. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $MR_nX_{y-n}$ ;

wherein M is a Group 15 metal;

each R is a monovalent C<sub>1</sub> to C<sub>12</sub> hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;

*n* is an integer from 0 to 4;

*y* is 3, 4 or 5, wherein *n* is less than *y*; and

each X is a halogen.

46. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $M(RO)_nR'_mX_{y-(m+n)}$ ;

wherein M is a Group 15 metal,

each RO is a monovalent C<sub>1</sub> to C<sub>30</sub> hydrocarboxy radical independently selected from the group consisting of an alkoxy, aryloxy, arylalkoxy, alkylaryloxy radicals;

each R' is a monovalent C<sub>1</sub> to C<sub>12</sub> hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;

*n* is an integer from 0 to 4;

*m* is an integer from 0 to 4;

*y* is 3, 4 or 5, wherein the sum of *n* and *m* is less than *y*; and

each X is a halogen.

47. The copolymer of claim 23, wherein the one or more Lewis acid(s) is represented by the formula  $M(RC=OO)_nR'_mX_{y-(m+n)}$ ;

wherein M is a Group 15 metal;

each RC=OO is a monovalent C<sub>2</sub> to C<sub>30</sub> hydrocarbacyloxy radical independently selected from the group consisting of an alkacyloxy, arylacyloxy, arylalkylacyloxy, alkylarylacyloxy radicals;

each R' is a monovalent C<sub>1</sub> to C<sub>12</sub> hydrocarbon radical independently selected from the group consisting of an alkyl, aryl, arylalkyl, alkylaryl and cycloalkyl radicals;

*n* is an integer from 0 to 4;

*m* is an integer from 0 to 4;

$y$  is 3, 4 or 5, wherein the sum of  $n$  and  $m$  is less than  $y$ ; and each X is a halogen.

48. The copolymer of claim 23, wherein the one or more Lewis acid(s) is independently selected from the group consisting of titanium tetrachloride, titanium tetrabromide, vanadium tetrachloride, tin tetrachloride, zirconium tetrachloride, titanium bromide trichloride, titanium dibromide dichloride, vanadium bromide trichloride, tin chloride trifluoride, benzyltitanium trichloride, dibenzyltitanium dichloride, benzylzirconium trichloride, dibenzylzirconium dibromide, methyltitanium trichloride, dimethyltitanium difluoride, dimethyltin dichloride, phenylvanadium trichloride, methoxytitanium trichloride, *n*-butoxytitanium trichloride, di(isopropoxy)titanium dichloride, phenoxytitanium tribromide, phenylmethoxyzirconium trifluoride, methyl methoxytitanium dichloride, methyl methoxytin dichloride, benzyl isopropoxyvanadium dichloride, acetoxytitanium trichloride, benzoylzirconium tribromide, benzoyloxytitanium trifluoride, isopropoyloxytin trichloride, methyl acetoxytitanium dichloride, benzyl benzoyloxyvanadium chloride, vanadium oxytrichloride, aluminum trichloride, boron trifluoride, gallium trichloride, indium trifluoride, ethylaluminum dichloride, methylaluminum dichloride, benzylaluminum dichloride, isobutylgallium dichloride, diethylaluminum chloride, dimethylaluminum chloride, ethylaluminum sesquichloride, methylaluminum sesquichloride, trimethylaluminum, triethylaluminum, methoxyaluminum dichloride, ethoxyaluminum dichloride, 2,6-di-*tert*-butylphenoxyaluminum dichloride, methoxy methylaluminum chloride, 2,6-di-*tert*-butylphenoxy methylaluminum chloride, isopropoxygallium dichloride, phenoxy methylindium fluoride, acetoxyaluminum dichloride, benzoyloxyaluminum dibromide, benzoyloxygallium difluoride, methyl acetoxyaluminum chloride, isopropoyloxyindium trichloride, antimony hexachloride, antimony hexafluoride, arsenic pentafluoride, antimony chloride pentafluoride, arsenic trifluoride, bismuth trichloride arsenic fluoride tetrachloride,

tetraphenylantimony chloride, triphenylantimony dichloride, tetrachloromethoxyantimony, dimethoxytrichloroantimony, dichloromethoxyarsine, chlorodimethoxyarsine, difluoromethoxyarsine, acetatotetrachloroantimony, (benzoato) tetrachloroantimony, and bismuth acetate chloride.

49. The copolymer of claim 23, wherein the one or more Lewis acid(s) is independently selected from the group consisting of aluminum trichloride, aluminum tribromide, ethylaluminum dichloride, ethylaluminum sesquichloride, diethylaluminum chloride, methylaluminum dichloride, methylaluminum sesquichloride, dimethylaluminum chloride, boron trifluoride, and titanium tetrachloride.
50. The copolymer of claim 23, wherein the Lewis acid is not a compound represented by formula  $MX_3$ , where M is a group 13 metal, X is a halogen.
51. The copolymer of claim 23, wherein the one or more initiator(s) comprise a hydrogen halide, a carboxylic acid, a carboxylic acid halide, a sulfonic acid, an alcohol, a phenol, a polymeric halide, a tertiary alkyl halide, a tertiary aralkyl halide, a tertiary alkyl ester, a tertiary aralkyl ester, a tertiary alkyl ether, a tertiary aralkyl ether, an alkyl halide, an aryl halide, an alkylaryl halide or an arylalkylacid halide.
52. The copolymer of claim 23, wherein the one or more initiator(s) is independently selected from the group consisting of HCl,  $H_2O$ , methanol,  $(CH_3)_3CCl$ ,  $C_6H_5C(CH_3)_2Cl$ , (2-Chloro-2,4,4-trimethylpentane) and 2-chloro-2-methylpropane.
53. The copolymer of claim 23, wherein the one or more initiator(s) is independently selected from the group consisting of hydrogen chloride, hydrogen bromide, hydrogen iodide, acetic acid, propanoic acid, butanoic acid, cinnamic acid, benzoic acid, 1-chloroacetic acid, dichloroacetic acid,

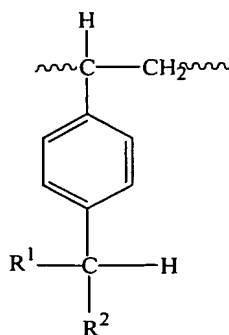
trichloroacetic acid, trifluoroacetic acid, p-chlorobenzoic acid, p-fluorobenzoic acid, acetyl chloride, acetyl bromide, cinnamyl chloride, benzoyl chloride, benzoyl bromide, trichloroacetylchloride, trifluoroacetylchloride, p-fluorobenzoylchloride, methanesulfonic acid, trifluoromethanesulfonic acid, trichloromethanesulfonic acid, p-toluenesulfonic acid, methanesulfonyl chloride, methanesulfonyl bromide, trichloromethanesulfonyl chloride, trifluoromethanesulfonyl chloride, p-toluenesulfonyl chloride, methanol, ethanol, propanol, 2-propanol, 2-methylpropan-2-ol, cyclohexanol, benzyl alcohol, phenol, 2-methylphenol, 2,6-dimethylphenol, p-chlorophenol, p-fluorophenol, 2,3,4,5,6-pentafluorophenol, and 2-hydroxynaphthalene.

54. The copolymer of claim 23, wherein the one or more initiator(s) is independently selected from the group consisting of 2-chloro-2,4,4-trimethylpentane; 2-bromo-2,4,4-trimethylpentane; 2-chloro-2-methylpropane; 2-bromo-2-methylpropane; 2-chloro-2,4,4,6,6-pentamethylheptane; 2-bromo-2,4,4,6,6-pentamethylheptane; 1-chloro-1-methylethylbenzene; 1-chloroadamantane; 1-chloroethylbenzene; 1, 4-bis(1-chloro-1-methylethyl) benzene; 5-tert-butyl-1,3-bis(1-chloro-1-methylethyl) benzene; 2-acetoxy-2,4,4-trimethylpentane; 2-benzoyloxy-2,4,4-trimethylpentane; 2-acetoxy-2-methylpropane; 2-benzoyloxy-2-methylpropane; 2-acetoxy-2,4,4,6,6-pentamethylheptane; 2-benzoyl-2,4,4,6,6-pentamethylheptane; 1-acetoxy-1-methylethylbenzene; 1-acetoxyladamantane; 1-benzoyloxyethylbenzene; 1,4-bis(1-acetoxy-1-methylethyl) benzene; 5-tert-butyl-1,3-bis(1-acetoxy-1-methylethyl) benzene; 2-methoxy-2,4,4-trimethylpentane; 2-isopropoxy-2,4,4-trimethylpentane; 2-methoxy-2-methylpropane; 2-benzoyloxy-2-methylpropane; 2-methoxy-2,4,4,6,6-pentamethylheptane; 2-isopropoxy-2,4,4,6,6-pentamethylheptane; 1-methoxy-1-methylethylbenzene; 1-methoxyadamantane; 1-methoxyethylbenzene; 1,4-bis(1-methoxy-1-methylethyl) benzene; 5-tert-butyl-1,3-bis(1-methoxy-1-methylethyl) benzene, and 1,3,5-tris(1-chloro-1-methylethyl) benzene.

55. The copolymer of claim 23, wherein the one or more initiator(s) further comprise a weakly-coordinating anion.
56. The copolymer of claim 23, wherein the one or more initiator(s) comprise greater than 30 ppm water (based upon weight).
57. The copolymer of claim 23, wherein the contacting further comprises contacting one or more monomer(s) independently selected from the group consisting of olefins, alpha-olefins, disubstituted olefins, isoolefins, conjugated dienes, non-conjugated dienes, styrenics, substituted styrenics, and vinyl ethers.
58. The copolymer of claim 23, wherein the contacting further comprises contacting one or more monomer(s) independently selected from the group consisting of styrene, para-alkylstyrene, para-methylstyrene, alpha-methyl styrene, divinylbenzene, diisopropenylbenzene, isobutylene, 2-methyl-1-butene, 3-methyl-1-butene, 2-methyl-2-pentene, isoprene, butadiene, 2,3-dimethyl-1,3-butadiene,  $\beta$ -pinene, myrcene, 6,6-dimethyl-fulvene, hexadiene, cyclopentadiene, methyl cyclopentadiene, piperylene, methyl vinyl ether, ethyl vinyl ether, and isobutyl vinyl ether.
59. The copolymer of any of the preceding claims, wherein the copolymer is halogenated to form a halogenated copolymer.
60. The copolymer of claim 59, wherein the halogenated copolymer is halogenated with chlorine or bromine.
61. The copolymer of claim 59 or 60, wherein the halogen content is greater than 0.2 mol%.

62. The copolymer of claim 59 or 60, wherein the halogen content is from 0.2 mol% to 5.0 mol%, preferably from 0.2 mol% to 2.0 mol%.
63. The copolymer of any of the preceding claims, wherein the copolymer has a Mw of from greater than 50,000.
64. The copolymer of any of the preceding claims, wherein the copolymer has a Mw of from greater than 100,000.
65. The copolymer of any of the preceding claims, wherein the copolymer has a Mw of from greater than 500,000.
66. The copolymer of any of the preceding claims, wherein the copolymer has a Mw of from greater than 1,000,000.
67. The copolymer of any of the preceding claims, wherein the copolymer has a MWD of from less than 3.
68. The copolymer of any of the preceding claims, wherein the copolymer has a MWD of from 2 to 5.
69. The copolymer of any of the preceding claims, wherein the copolymer has a Mooney viscosity of at least  $20 \pm 5$  (ML 1 + 8 at 125°C, ASTM D 1646).
70. The copolymer of any of the preceding claims, wherein the copolymer has a Mooney viscosity of from  $20 \pm 5$  to  $60 \pm 5$  (ML 1 + 8 at 125°C, ASTM D 1646).
71. A functionalized or halogenated copolymer derived from a copolymer comprising a C<sub>4</sub>-C<sub>7</sub> isoolefin, preferably isobutylene, and an alkylstyrene, preferably methylstyrene, more preferably *para*-methylstyrene, represented by the formula:





wherein each  $R^1$  and  $R^2$  are independently selected from the group consisting of hydrogen, an alkyl, a primary haloalkyl, and a secondary haloalkyl; the copolymer having a copolymer sequence distribution defined by:

$$F = 1 - \{m A / (1 + mA)\}$$

wherein  $m$  is the copolymer sequence distribution parameter;  $A$  is the molar ratio of alkylstyrene to isoolefin in the copolymer; and  $F$  is the alkylstyrene-isoolefin-alkylstyrene triad fraction in the copolymer; wherein  $m$  is from less than 38.

72. The functionalized or halogenated copolymer of claim 71, wherein  $m$  is from less than 35.
73. The functionalized or halogenated copolymer of claim 71, wherein  $m$  is from less than 30.
74. The functionalized or halogenated copolymer of claim 71, wherein  $m$  is from 1-38.
75. The functionalized or halogenated copolymer of claim 71, wherein  $m$  is from 1-35.

76. The functionalized or halogenated copolymer of claim 71, wherein m is from 1-30.
77. The functionalized or halogenated copolymer of any of the preceding claims, wherein the alkylstyrene content is from greater than 0.5 mol%.
78. The functionalized or halogenated copolymer of any of the preceding claims, wherein the alkylstyrene content is from greater than 1.5 mol%.
79. The functionalized or halogenated copolymer of any of the preceding claims, wherein the alkylstyrene content is from greater than 6.0 mol%.
80. The functionalized or halogenated copolymer of any of the preceding claims, wherein the alkylstyrene content is from greater than 12.5 mol%.
81. The functionalized or halogenated copolymer of any of the preceding claims, wherein the isoolefin and the alkylstyrene are present in the copolymer in amounts such that the isoolefin is from about 75.0 wt% to 99.5 wt% of the copolymer and the alkylstyrene is from about 25.0 wt% to 0.5 wt% of the copolymer (based upon the weight of the copolymer).
82. The functionalized or halogenated copolymer of any of claims 71-80, wherein the isoolefin and the alkylstyrene are present in the copolymer in amounts such that the isoolefin is from about 10.0 wt% to 99.5 wt% of the copolymer and the alkylstyrene is from about 90.0 wt% to 0.5 wt% of the copolymer (based upon the weight of the copolymer).
83. A blend comprising the copolymer or functionalized or halogenated copolymer of any of the preceding claims and a secondary rubber independently selected from the group consisting of at least one of natural rubber, polyisoprene rubber, poly(styrene-co-butadiene) rubber (SBR),

polybutadiene rubber (BR), poly(isoprene-*co*-butadiene) rubber (IBR), styrene-isoprene-butadiene rubber (SIBR), ethylene-propylene rubber (EPR), ethylene-propylene-diene rubber (EPDM), polysulfide, isobutylene/cyclopentadiene copolymer rubber, isobutylene/methyl cyclopentadiene copolymer rubber, nitrile rubber, propylene oxide polymers, star-branched butyl rubber and halogenated star-branched butyl rubber, brominated butyl rubber, chlorinated butyl rubber, star-branched polyisobutylene rubber, star-branched brominated butyl (polyisobutylene/isoprene copolymer) rubber; poly(isobutylene-*co-p*-methylstyrene) and halogenated poly(isobutylene-*co-p*-methylstyrene), halogenated poly(isobutylene-*co*-isoprene-*co-p*-methylstyrene), poly(isobutylene-*co*-isoprene-*co*-styrene), halogenated poly(isobutylene-*co*-isoprene-*co*-styrene), poly(isobutylene-*co*-isoprene-*co*- $\alpha$ -methylstyrene) halogenated poly(isobutylene-*co*-isoprene-*co*- $\alpha$ -methylstyrene), and mixtures thereof.